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MADROÑO

A WEST AMERICAN JOURNAL OF BOTANY

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January, 1952

MADROÑO

A WEST AMERICAN JOURNAL OF BOTANY

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THE THIRD LOCALITY FOR CUPRESSUS ABRAMSIANA WOLF

Calvin McMillan

At the time of publication of The New World Cypresses (1948), C. B. Wolf had been unable to locate the area where cypresses were reportedly growing on Butano Ridge in San Mateo County, California. A record of their presence in that region was found in the Dudley Herbarium, the specimens having been first collected by Professor W. R. Dudley, and it was with hesitance that Wolf referred the trees in this third locality to his newly named species, *Cupressus Abramsiana*, which included trees from the Bonny Doon and Eagle Rock areas of Santa Cruz County. Subsequently this reported population has been the object of many searches on the Butano Ridge. Several years ago H. A. Dutton of Los Altos was taken to the cypress locality by James Allen, Deputy Fire Warden of San Mateo County, and it was through their assistance and in their company that the locality was revisited on September 1, 1951. Herbarium material, as well as a large collection of cones, was obtained from Butano Ridge for comparison with material from the other two populations which were revisited on the same date.

The Butano Ridge cypress area is easily reached from the old lumber road along the crest of the ridge. The point of descent from the ridge road is 3.2 miles from the locked gate at the entrance to the Locatelli Mill, north of Big Basin. By travelling about one-half mile on the surfaced road leading into the mill and then turning onto the dirt road along the ridge and following it for 2.7 miles, an old lumber trail is encountered which sharply descends the Butano Creek side of the ridge. A trek of approximately one-quarter mile down the slope leads directly into the cypress area, which probably includes the common corner of sections 11, 12, 13, and 14, of Township 8 South, Range 4 West, Mount Diablo Base and Meridian, Santa Cruz quadrangle.

The stand of cypresses is approximately eight to ten acres in area containing as a rough estimate five thousand trees. Some of the larger cypresses are sixty to seventy-five feet in height with the average being possibly twenty to thirty feet. The entire cypress population is visible from a portion of exposed sandstone in the area and was found to be surrounded on all sides by a taller forest composed principally of *Sequoia sempervirens* (Lamb.) Endl., *Pseudotsuga taxifolia* (Lamb.) Britt., and *Arbutus Menziesii* Pursh. Within the cypress area, no other trees were found, but of the shrubs, *Adenostoma fasciculatum* H. & A. was the most

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abundant. *Sphacele calycina* Benth., *Eriodictyon californicum* (H. & A.) Greene and *Arctostaphylos tomentosa* (Pursh) Lindl. were other common shrubs of the cypress area.

The cause for the restriction of the cypress to this locality is possibly in part edaphic. The soil is extremely shallow and in many places the sandstone bedrock was exposed or could be exposed by the removal of a few inches of soil. The sharply sloping hillside precludes any great aggregation of soil which might favor the growth of the taller forest. The common occurrence of sandstone exposures along Butano Ridge, however, reveals little reason for the restriction of cypress to one isolated area.

The three populations included in *C. Abramsiana* by Wolf were formerly treated as *C. Sargentii* after Jepson (1909) separated that taxon from *C. Goveniana* Gord. Wolf considered *C. Abramsiana* to be intermediate between *C. Sargentii* and *C. Goveniana*. He pointed out that it did not have the dusty-green foliage of *C. Sargentii*, but did have the glaucous seeds of that species. A closer relationship seemed to be with *C. Goveniana*, which it resembled in having light green foliage. Wolf admitted that no outstanding characters separated *C. Abramsiana* from the other two species, but decided that if *C. Sargentii* and *C. Goveniana* were to be maintained as distinct, the intermediate should be treated as a co-ordinate species.

The isolation of the three populations of *C. Abramsiana* from one another is sufficient to preclude any free interchange of genic material, and it is not surprising then to find variation from one population to another. The northern population at Butano Ridge is approximately eight miles north of the Eagle Rock locality, while the Bonny Doon population is seven miles south of Eagle Rock. The possibility of intervening populations or isolated trees along this 15 mile span cannot be dismissed, for owing to the ruggedness of the terrain, the Santa Cruz Mountains are still not completely known floristically.

A striking difference among the populations is to be found in the size of the female cone. Those of the northern population at Butano Ridge are the largest, those at Eagle Rock are intermediate and those at Bonny Doon are the smallest (fig. 1). Variation exists within each population as might be expected. One hundred cones selected from a random collection of each population were measured. The average length of the Butano Ridge population was 28 mm., that of the Eagle Rock population was 24 mm., while that of the Bonny Doon population measured 21 mm. The average cone of each population was slightly elongated. The number of cone-scales of the Butano Ridge population was the most

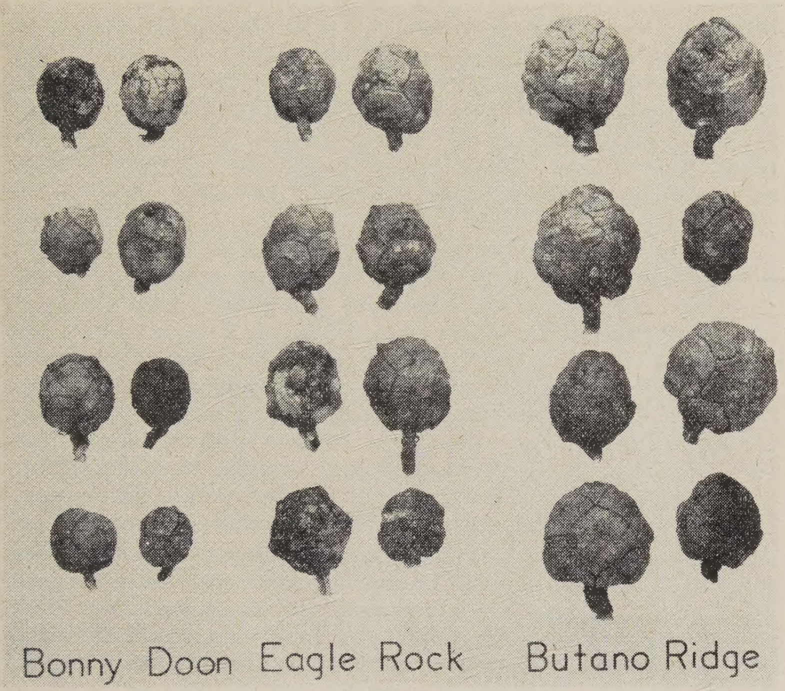

FIG. 1. A random selection of cones from the three populations of *Cupressus Abramsiana* Wolf.

variable, but cones composed of 10 and 12 scales were common, the average being represented by the figure 10.4. The Bonny Doon and Eagle Rock populations were predominantly of 8-scaled cones, although the average number for the hundred cones was found to be 8.5 and 8.7 respectively. None of the populations regularly produces cones as small as those of *C. Goveniana,* which are from 10 to 15 mm. long and nearly globose. The mature cones of the many disjunct populations of *C. Sargentii,* however, are extremely variable, the extremes in length measuring 15 and 30 mm. The Bootjack, Mount Tamalpais population of *C. Sargentii* in Marin County is characterized by rather large cones, but none exceeds 30 mm. in length and the majority measure between 20 and 30 mm. The number of cone-scales is usually from 6 to 8 in both *C. Goveniana* and *C. Sargentii.*

The type specimen of *C. Abramsiana* from Bonny Doon is reported by Wolf to have very glaucous seeds. Approximately half of the cones from Bonny Doon yielded glaucous seeds, but at the Eagle Rock and Butano Ridge areas very few produce even slightly glaucous seeds. The seeds of all three populations vary from light to dark brown. Seed-size seems to be correlated with the size of the cones, the smallest, of which the average length was 4 mm., being from the Bonny Doon area and the largest, being from Butano Ridge with the average measuring 4.5 mm. In contrast, seeds produced by *C. Goveniana* are non-glaucous, dark brown to dull black, and mostly 3 mm. in length, while *C. Sargentii* regularly produces glaucous seeds which are dark brown and vary in length from 4 to 5 mm.

As has been indicated, the foliage of *C. Sargentii* is a dusty-green, while that of *C. Goveniana* is a light green. In regard to color, the foliage of the three populations of *C. Abramsiana* is more similar to that of *C. Goveniana*. While the Bonny Doon area has many smaller trees, of a yellow green color, growing on sandstone exposures, many of the larger trees have dark green foliage. In contrast to the rather coarse foliage of the cypresses in the Bonny Doon area, those of Butano Ridge have foliage which is characteristically much finer. In its type of foliage, the Eagle Rock population more closely resembles that of Butano Ridge.

In addition to morphological differences, a distinct difference of habitat characterizes *C. Sargentii, C. Abramsiana* and *C. Goveniana. Cupressus Sargentii* is known only from serpentine areas distributed in the coast ranges from northern Mendocino County to Santa Barbara County. In its widely disjunct pattern of distribution, it resembles many other serpentine-restricted species. In contrast, *C. Goveniana* is known from only two small disjunct populations in Monterey County, where it occurs on a sandy podsolic soil on Huckleberry Hill and on a sandy outcropping near San Jose Creek behind Point Lobos. [As treated by Abrams (1923), and by McMinn (1935, 1939), *C. Goveniana* includes, in addition to the Monterey populations, those Mendocino County populations which are considered here to be *C. pygmaea* (Lemm.) Sarg.] *Cupressus Abramsiana* is restricted to soils which are principally derived from sandstone. In a discussion of the distributional patterns of members of the genus *Cupressus*, Mason (1946) noted a suggestion of a relationship with edaphic conditions. He was led to conclude that speciation in the genus has been rather closely related to edaphic patterns of environmental restriction. The Bonny Doon population of *C. Abramsiana* is found to be growing with *Pinus attenuata* Lemm. and two narrowly-restricted species of *Arctostaphylos, A. sensitiva* Jepson, which is confined to dry mountain slopes of the Santa Cruz Mountains and of southern Marin County, and *A. silvicola* Jeps. and Wies., which is confined to sand deposits in the Mount Hermon region of the Santa Cruz Mountains. Some of the largest cypresses at Bonny Doon occur in the deeper sandy soils with *Pinus ponderosa* Dougl. At Eagle Rock, some *Pinus attenuata* is growing on the crest of the ridge, but over most of the cypress area, it is absent. A dense brush cover composed of *Adenostoma fasciculatum* H. &. A., *Ceanothus cuneatus* (Hook.) Nutt., *Photinia arbutifolia* Lindl. and *Pickeringia montana* Nutt. is the main associated vegetation. As has been indicated, the Butano Ridge cypresses are found principally with *Adenostoma fasciculatum,* and although *Pinus attenuata* is frequent along Butano Ridge, none was found growing within the cypress area. The distributional patterns might suggest that the cypress and pine are growing together at Bonny Doon because they each have different requirements of the environment and that only the cypress requirements are fulfilled at Butano Ridge. On the other hand, a suggestion that a different physiological tolerance characterizes each population of cypress seems worthy of consideration. From studies in progress, it would seem that the premise of different requirements by pines and by cypresses at Bonny Doon is well substantiated. And it seems not at all unlikely that physiological differences characterize the three populations of cypress as much as morphological ones. *Pinus attenuata* is one of the Californian plants which would be considered *"bodenwag"* in that it is not restricted to one soil type but is found on serpentine as well as other soils, and its presence therefore with *C. Sargentii* in some areas of Napa and Lake counties is not unexpected. However, whether *P. attenuata* be differentiated into races tolerant and intolerant of serpentine soils, as has been recently demonstrated by Kruckeberg (1951) for certain herbaceous *bodenwag* species which occur on serpentine soils, is yet to be ascertained. At any rate, *C. Sargentii* is found with *P. attenuata* but is more commonly to be found in areas with *P. Sabiniana* Dougl. As might be expected of a species widely disjunct in its distribution, *C. Sargentii* is found growing with different plants in northern Mendocino County from those in Santa Barbara County, but is found commonly with the shrubby species which characterize the Eagle Rock and Butano Ridge areas of *C. Abramsiana. Cupressus Goveniana* occurs in areas of greater rainfall than does *C. Sargentii* and *C. Abramsiana,* and is found on Huckleberry Hill, with one of the disjunct populations of *Pinus muricata.* Here also, a few large cypresses grow with *Pinus radiata* Don, but the greatest concentration of cypresses are dwarfed and confined to a limited area with a low growth of *P. muricata, Arctostaphylos Hookeri* Don, and *Arctostaphylos tomentosa* (Pursh) Lindl. The species composition of both the Huckleberry Hill and San Jose Creek cypress stands bears little similarity to that found in the *C. Abramsiana* and *C. Sargentii* areas.

In an attempt to explain the characteristics of *C. Abramsiana* which are, in some respects, intermediate between *C. Sargentii* and *C. Goveniana,* an origin resulting from hybridization of those two species might by hypothesized. The Santa Cruz Mountains, where *C. Abramsiana* is restricted, lie equidistant from *C. Goveniana* localities of Monterey County to the south, from the *C. Sargentii* locality of Mount Tamalpais, Marin County, to the north, and from the *C. Sargentii* locality of Cedar Mountain, Alameda County, to the east. The distance in each instance is approximately 50 miles, a separation which removes a reasonable possibility of gene exchange at the present time. However, the fossil record indicates that *Cupressus* has grown in many places along the coast of California where it is now absent from the existing flora. Pleistocene fragments and cones which are similar to present *C. Goveniana* have been referred to that species by Chaney and Mason (1930), largely by reason of their being found with cones of *P. muricata,* a species with which *C. Goveniana* occurs today. The existence of colonies of *C. Goveniana* and *C. Sargentii* in mutual proximity during the Pleistocene would have facilitated hybridization, while subsequent isolation with biotype depletion (Stebbins, 1942) acting to confine the species, would have allowed for sufficient divergence of *C. Abramsiana* from either species. As it is understood at the present time, *C. Abramsiana* may be regarded as a discrete but highly variable entity. Its relationship is certainly not so close to *C. Goveniana* as is that of *C. pygmaea* and yet there are decided morphological and ecological differences which oblige the separation of *C. Abramsiana* from *C. Sargentii.*

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BACTERIAL LEAF SPOT OF UMBELLULARIA CALIFORNICA[1]

JOHN M. HARVEY[2]

Diseased leaves were collected from a California laurel tree, *Umbellularia californica* Nuttall, located on the west slope of the Berkeley hills just east of the University of California campus. Plants growing in this area are subjected to relatively high moisture conditions due to the coastal fogs which prevail through several months of the year. Leaves of *U. californica* were also collected extensively in other coastal areas of California from Santa Cruz to Mendocino counties. The disease under discussion, however, was found only on trees in the Berkeley area.

SYMPTOMS

Black, angular leaf spots, delimited more or less by the small veinlets in the leaves, are the symptoms of this disease (fig. 1). In old infections the central part of the spot dies and the area around the periphery of the spot often yellows. Necrotic spots often contain swollen portions which, when pierced by a dissecting needle, yield a white bacterial ooze. The disease appears to be associated with wounds since it is often found in nature on leaves which have been scratched due to wind movement; in artificial inoculations only occasional infections were induced on unwounded leaves. When the leaves are extensively wounded and inoculated, infection is very severe, the spots become confluent and eventually the whole leaf is killed.

ISOLATION OF THE CAUSAL AGENT AND INOCULATION OF THE HOST

The diseased areas of leaves were cut out and surface sterilized by dipping in 95 per cent ethyl alcohol for one second, after which they were placed in a 1-1000 solution of mercuric chloride for one minute according to the method outlined by Elliott (1920). The diseased portions of leaves were then washed successively in ten sterile water blanks and placed in a dry, sterile petri dish to drain. Sterile instruments were used to cut out and place the individual diseased spots of the leaf on potato dextrose agar plates.

After forty-eight hours of culturing bacteria grew out onto the medium from the leaf sections thus prepared.

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[1] A revision of a section of a thesis submitted to the Graduate Division of the University of California at Berkeley in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

[2] The author wishes to acknowledge his indebtedness to Dr. H. N. Hansen and other members of the Division of Plant Pathology for counsel and advice in this work.

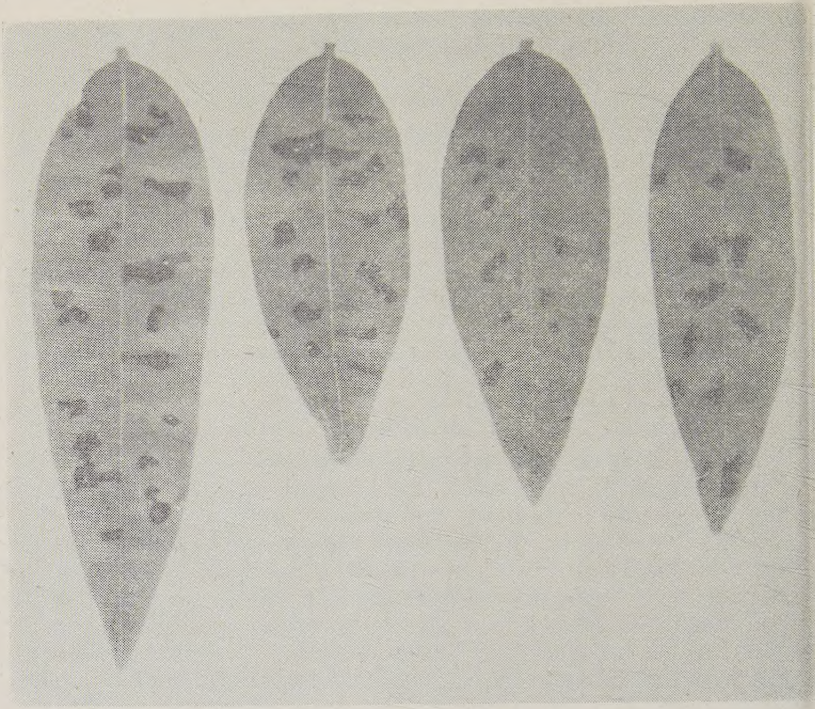

Fig. 1. Infected leaves of *Umbellularia californica* after artificial inoculation with *Pseudomonas lauracearum.*

A small amount of this inoculum was transferred to a sterile water blank and from this bacterial suspension streaks were made on potato dextrose plates. Streaks made from the resultant colonies produced pure cultures of the pathogen which were maintained on potato dextrose slants.

The work of Johnson (1947) suggests the value of predisposing plants to infection by means of water congestion. Accordingly, one year-old potted seedlings of *U. californica* were placed in a moist chamber out of doors in Berkeley, California, for forty-eight hours. Such a moist environment is often approximated in the foggy area where the disease was observed.

Two leaves on each seedling were then wounded by puncturing with a dissecting needle, two by scratching with a dissecting needle and the remainder were left unwounded. These seedlings were sprayed with a suspension of the bacterium isolated from diseased *U. californica* leaves and were returned to the moist chamber for an additional seventy-two hours. Thereupon the plants were removed and placed in a shaded location out of doors. Seven days after inoculation, black spots were visible on the punctured and scratched leaves and on the latter the spots soon became confluent, the infection spreading over the whole leaf. Immature leaves did not become infected indicating that entrance of the pathogen is probably not through the stomata. Infection occurred rarely on unwounded leaves. However, in a few of the older, unwounded leaves, lesions occasionally appeared near the tips and lateral margins, pointing to the possible entry of bacteria through hydathodes.

The bacterium was reisolated from these artificially induced lesions by the same method as used for the original isolation. Subsequent inoculations made with this reisolate produced typical symptoms.

Seedlings of orange *(Citrus sinensis* Osbeck), Pinto bean *(Phaseolus vulgaris* L.) and avocado *(Persea drymifolia* Cham. & Schlecht.) were inoculated in the same manner as were the *Umbellularia californica* seedlings. Avocado was the only one of these plants that became infected. *Umbellularia* and avocado are in the same family, Lauraceae.

In the avocado, infection occurred at various places on the leaf and appeared to be through the stomata, rather than following wounding. The spots were somewhat smaller and less angular than on *U. californica*. Reisolation of the organism from the avocado spots yielded the same organism with which the plant was originally inoculated.

Since the leaves of *U. californica* remain on the tree for several years, the pathogen is probably held over from season to season in infected leaves. The life cycle of this organism, therefore, appears to be relatively simple, the bacterium passing from old infected leaves to younger ones, dissemination probably being by rain, and penetration being chiefly through wounds caused by wind action or insects.

CLASSIFICATION

This organism appears to differ in a number of ways from bacterial organisms previously described and it does not key out to any known species of the Schizomycetes as listed in Bergey's Manual (1948). The organism isolated from *U. californica* is, therefore, proposed as a new species:

Pseudomonas lauracearum sp. nov. A motile rod with rounded ends and polar flagella; single, in pairs, or chains; average measurement 1.8 — 6.4 × 0.7 — 0.8 microns; non spore forming; aerobic; Gram-negative, non-acid-fast. On potato dextrose agar colonies white, butyrous, granular, flat, irregular in shape with lobate margins and opalescent luster; on beef peptone agar growth filiform, colonies cream colored, medium unchanged; liquification of gelatin slow and of the stratiform type; white pellicle formed on nutrient broth and on potato dextrose broth; no growth in Cohn's solution nor on Fermi's medium, but moderate growth in Uschinsk's solution; growth retarded on culture medium containing 2½ per cent sodium chloride, no growth on culture medium containing 5 per cent sodium chloride; vitality on most culture media short. Acid, but no gas produced with glucose, sucrose, d-mannose, d-galactose and d-mannitol; no acid or gas produced with fructose, lactose, and dextrin. Starch not hydrolized, indol and hydrogen sulphide not produced; nitrates reduced to nitrites and nitrites to ammonia. Maximum temperature for growth 31° C., minimum 7° C. and optimum 22° C. Maximum pH for growth 9.2, minimum 5.4 and optimum 6.03. Pathogenic on *Umbellularia californica* Nutt. causing angular leaf spots; also pathogenic on leaves of avocado, *Persea drymifolia* Cham. and Schlecht. following inoculation. Specific name refers to the fact that both host plants belong to the family Lauraceae. Culture deposited with the American Type Culture Collection.

United States Horticultural Field Station
Bureau of Plant Industry, U.S.D.A.
Fresno, California

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HOWELLANTHUS, A NEW SUBGENUS OF PHACELIA

LINCOLN CONSTANCE

Phacelia Dalesiana J. T. Howell, published (1937) under the title, "A Remarkable New Phacelia," fully lives up to the descriptive adjective. Although the author referred this northern California species to section *Euphacelia* "on characters of flowers and ovules," it was clear to him at the time that it was unique in many respects, and he has assured me that only its apparent similarity to "some otherwise entirely unrelated Mexican species" prevented him from describing it as a monotypic new genus. The possession of true interstaminal corolla scales and paired ovules afford it technical admission to *Euphacelia*, but it comprises a markedly discordant element in that section.

The writer's recent study of the subgenus *Cosmanthus* (1949) has provided data to permit comparison with the Mexican species mentioned above, and the cytological data accumulated by Cave and Constance (1942, 1944, 1947, 1950) afford a basis for contrasting *Phacelia Dalesiana* with other species and genera of Hydrophyllaceae in respect to chromosome number.

The following review of characters roughly parallels that employed for the species of *Cosmanthus.*

HABIT. The habit of *Phacelia Dalesiana* (fig. 1, a), a deep-rooted, acaulescent perennial herb arising from a more or less definite basal rosette of entire leaves, superficially resembles that of the Mexican *P. (Cosmanthus) platycarpa* and the genera *Hesperochiron* and *Tricardia.* No other western American *Phacelia* bears any close resemblance in this respect. Depressed forms of the *P. magellanica* complex may have both the acaulescent habit and the basal rosette of entire leaves, but in these the inflorescence is congested-scorpioid and the leaves are unmistakably characteristic of this rather discrete group. Some annual species of *Phacelia* share the entire basal leaves, but the habital distinction remains striking.

INFLORESCENCE. The few-flowered, lax inflorescence (fig. 1, a) is a little reminiscent of such annual species as *P. Eisenii, P. orogenes, P. Pringlei,* and *P. racemosa,* which also have deeply parted styles, as does *P. Dalesiana.*

GLANDS AND COROLLA SCALES. *Cosmanthus* is unique within *Phacelia* by its possession of a flap-bordered gland proximal to each corolla lobe, and there are no corolla scales present. *Phacelia Dalesiana,* on the other hand, is entirely devoid of these glands on the corolla, but has extremely well developed interstaminal scales (fig. 1, b). This species thus differs from *Cosmanthus* in the single morphological character peculiar to and distinctive of that subgenus. True interstaminal scales are, however, found in most species comprising sections *Eutoca, Euphacelia,* and *Euglypta.*

PUBESCENCE. *Phacelia* Dalesiana is more or less hirsutulous and slightly viscid, with an indument suggestive of that of *P. (Cosmanthus) dubia,* and the stamens are entirely glabrous. Neither of these conditions, however, is particularly distinctive in the genus as a whole.

OVULES AND SEEDS. Howell has emphasized the unique feature of the pendent attachment of the ovules at the summit of the placental ridges, and the production of a single pair of ovules by each placenta. Paired pendent ovules occur also in the monotypic genus *Draperia.* Geminate ovules are characteristic not only of section *Euphacelia,* but also of such species of *Cosmanthus* as *P. bipinnatifida, P. fimbriata, P. Purshii,* and *P. ranunculacea.* The numerical situation, alone, is probably an unreliable clue to affinity, inasmuch as tendencies toward reduction in the number of ovules appear to be very widespread among the angiosperms. It may suggest, however, that *Phacelia Dalesiana* is not necessarily particularly primitive.

CHROMOSOME NUMBER. The chromosome number of *P. Dalesiana* is n= 8 (fig. 1, e), a number known to be shared by three annual species, *P. glabra (Cosmanthus),* and by *P. marcescens* and *P. Quickii (Euphacelia fide* Howell, 1943). Of greater interest, perhaps, is the fact that both species of *Hesperochiron (H. californicus* and *H. pumilus)* likewise possess eight pairs of chromosomes. (The chromosome number of *Draperia* is n = 9; that of *Tricardia* has not been ascertained.) Although chromosome numbers thus far reported in *Phacelia* range from n = 5 to n = 24, the other perennial species of known cytology show only 9 *(Cosmanthus),* 10 (one species of *Euphacelia),* 11 *(Eutoca* and *Euphacelia),* and 22 tetraploid forms of *Euphacelia).*

Geographical Distribution. *Phacelia Dalesiana* is known to occur only within a very small area — straddling the Siskiyou-Trinity County line in California — on the upper slopes of Scott Mountain in the Trinity Mountains area. This ridge is part of a tangled mass of ranges which contribute to the topographic confusion of the Klamath-Siskiyou region, an area where remarkable species of restricted occurrence are especially abundant. Other species of the genus on Scott Mountain are *P. mutabilis,* chiefly in coniferous woods; *P. Pringlei,* in wet places, especially on or near serpentine; and *P. Greenei* and *P. corymbosa,* largely on drier serpentine or altered rock. In addition, *Hydrophyllum occidentale* grows with *Phacelia Dalesiana* in rather open, sandy, mineralized soil; *Hesperochiron californicus* is abundant in moist situations near at hand; and *Draperia systyla,* which occurs in woods in the same general area, may very probably be found on the same mountain.

On the basis of its acaulescent, perennial habit, entire leaves, scarcely scorpioid cymes, interstaminal scales, deeply parted style, pendent paired ovules, and its chromosome number, it is evident that *Phacelia Dalesiana* combines features common to various other members of the genus, but is not itself referable to any described subgenus or section. The hypothesis of close relationship of this species to any particular species-group would have to depend upon emphasizing a few salient similarities and ignoring striking discrepancies. Certainly no other known perennial species is at all comparable with *P. Dalesiana;* of the annuals, those sharing the inflorescence character differ in other important features, including chromosome complement, and appear to have no real relationship here. Thus, within *Phacelia,* the affinities of *P. Dalesiana* seem to be obscure, but there is also a lack of decisive characters to justify removing the species from the genus. All these considerations appear to recommend retention of *P. Dalesiana* within *Phacelia,* but as a distinct subgenus coordinate with *Cosmanthus.*

PHACELIA subgenus **Howellanthus** subgen. nov. Herbae perennes humiles pubescentes ex rosulis foliorum inte-

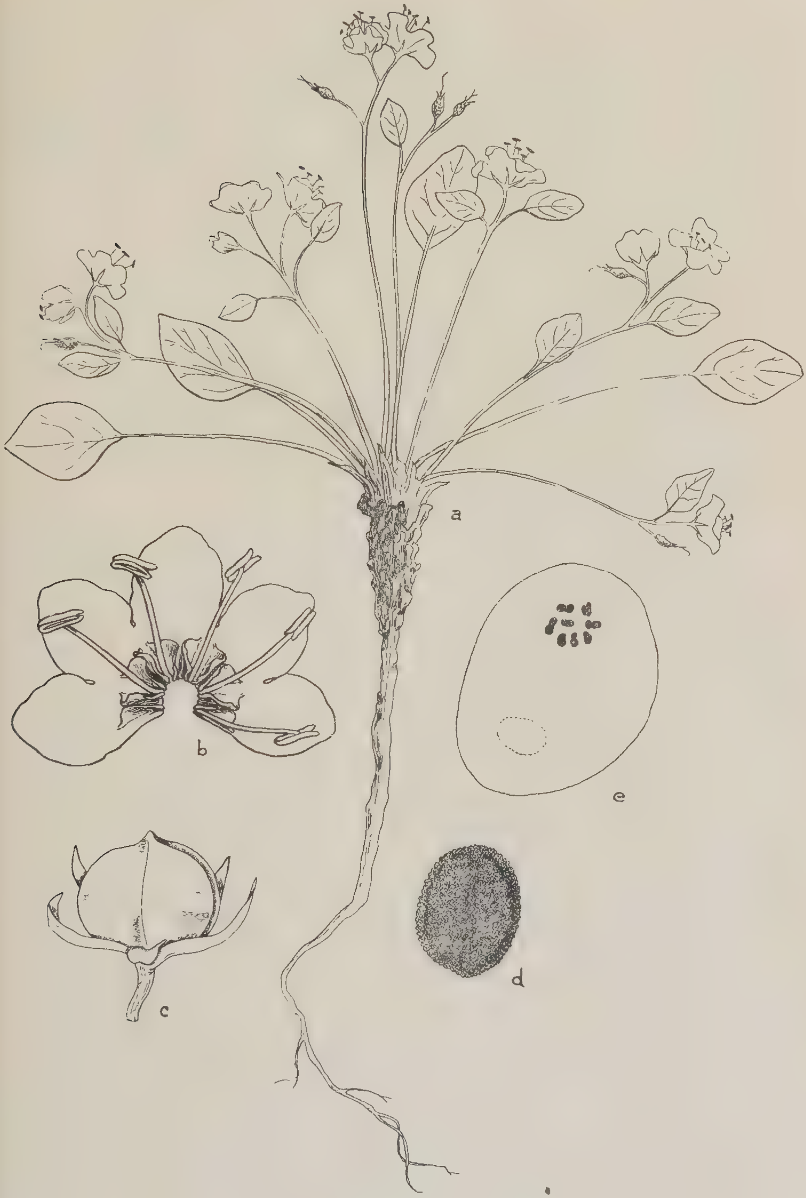

FIG. 1. *Phacelia Dalesiana. a,* habit, × 1; *b,* corolla, × 2½; *c,* mature capsule, × 4; *d,* mature seed, × 6; *e,* chromosome plate, II M, × 1600. (All illustrations from *Constance* & *Shan 3070,* UC 735,051.)

grorum basalibus foliis caulinis paucis alternantibus oppositisve floribus albis in cymis secundis vix scorpioidalibus. Corollae pelviformes staminibus squamis interstaminalibus eglandulosis suffultis. Ovarium lateraliter paululum compressum placentis duabus angustis intrusis haud connatis quasi divisum. Ovula exutraque placenta duo seminibus (plerumque duobus) leviter alveolatis sed transversim haud corrugatis.

Low, perennial, pubescent herbs with a basal rosette of entire leaves, the cauline leaves few, alternate or opposite, and white flowers in secund, scarcely scorpioid cymes. Corolla pelviform, the stamens subtended by a pair of conspicuous interstaminal scales, glands lacking. The ovary slightly compressed laterally, incompletely divided by the intrusion of two narrow parietal placentae, which are, however, not grown together. Ovules two to each placenta, the seeds (usually 2) finely alveolate, but not transversely corrugated. Chromosome number $n = 8$.

Type species, *P. Dalesiana* J. T. Howell, endemic in the Trinity Mountains area of northwestern California.

There remains to be considered Howell's suggestion that the species "might represent a relictual expression of an ancient type or complex from which not only the genera *Draperia* and *Hesperochiron* developed but also from which species-groups of modern *Phacelia* with less specialized habit and placentation have diverged." There is no intimation that *P. Dalesiana*, itself, has given rise to any other genera or species. *Draperia*, with its trailing, woody stems, opposite leaves, subsessile flowers, tubular-funnel form and shallowly lobed corollas, unequal and unequally inserted stamens, bilobed style, definitely bilocular capsule, and paired pendent ovules, is a monotypic genus with many indications of specialization. Its chromosome complement is 9 pairs. The sole resemblance to *P. Dalesiana*, the position and number of the ovules, would seem to be explicable much more easily as an instance of parallel evolution than as an indication of consanguinity. *Hesperochiron* resembles *P. Dalesiana* in its perennial, acaulescent habit, entire basal leaves, and in chromosome number. The (usually) solitary flowers, the funnelform or rotate corolla, the often unequal stamens with dilated filaments and somewhat versatile anthers, the shortly 2-cleft style, and the numerous ovules and seeds are all points of difference. Thus, *Draperia* and *Hesperochiron* appear to be rather highly specialized types of obscure lineage, the origin of which probably had no close proximity to that of *P. Dalesiana*, which stands sharply isolated even within its genus.

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GENETIC VARIATION IN ANDROPOGON

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There appear to be three species of *Andropogon* in Nebraska, *Andropogon Gerardi* Vitman (*A. furcatus* Muhl.), *A. Hallii* Hack., and *A. scoparius* Michx.

As a prelude to a taxonomic investigation of the Nebraska andropogons by the junior author, collections were made during the summers of 1949 and 1950 from eighty-three of the ninety-three counties of the state.[1] In making these collections, material was taken only from areas which showed no signs of recent disturbance. This precaution was taken to avoid, as far as possible, the sampling of populations which might be of hybrid origin, and especially those with a short life-span. The tendency for hybrids and other such genetically mixed individuals to occur along roadsides, railway embankments, in cultivated fields, washouts, and other such disturbed areas, has been pointed out by Heiser (1949).

In the field, the variation between the individual plants was very evident. The plants varied in the following respects:

(1) height of plant—low to tall,
(2) culm shape—cylindrical or flattened,
(3) foliage color—green or glaucous,
(4) anthocyanin content of culm and leaves—marked or absent,
(5) pubescence of leaf and culm—copious or light,
(6) anther color—red, yellow, or purple,
(7) length of rhizome internode—short or long.

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[1] This work was financed by a grant from the Research Council of the University of Nebraska.

When the collections were made, the rhizomes were carefully traced, some portions of the plant were pressed for preservation in the herbarium, and other portions of the same plant were tagged with the collection number and retained for garden and greenhouse culture. Thus the plants growing in the garden and greenhouse and the preserved herbarium specimen are members of the same clone, and are presumably genetically identical. In the greenhouse, the plants were grown under uniform conditions, and were allowed to become dormant in the fall. After a month of dormancy, they were exposed to artificial illumination comparable to a sixteen-hour day. Within four months, the plants in the greenhouse were in flower.

The clone members used for garden culture were planted as soon as possible, and the position of each specimen in the garden was plotted as a safeguard against possible loss of the metallic tag bearing the collection number. In the majority of cases, the individuals survived the transplanting and winter conditions, and resumed growth in the spring.

Comparison of the growing plants and respective herbarium specimens afforded a means of determining to what degree the variation observed in the field was controlled by the environment, and to what extent by the genetic constitution of the individual plants. If the members of the same species all reverted to a common morphology under the uniform culture conditions, it could be assumed that the variation found in the field was due entirely to the influence of the environment. If, however, some of the morphological variations observed in the field were retained when the variants were grown under uniform conditions, such variations could be assumed to be produced by differences in the genetic constitution of the plants. As has been pointed out by Clausen, Keck and Hiesey (1940), there is no reason to expect a cumulative effect after transplanting, since the alteration in the physiology of the plant is effected immediately, and changes in morphology show up with the new growth at once. Thus the results obtained from two years' culture may be considered valid.

Of the field variations mentioned above, none were found to be due entirely to the effects of the environment, and only one, the height of the plant, was found to be modified upon transplanting. Plant height, in *Andropogon Gerardi*, was found to vary in the field from eighteen to seventy-two inches, but these heights were not maintained after transplanting. This is probably to be expected because of the changed nutrition and the differential checking of the growth through transplanting. It was interesting to find that those plants which had been taller in the field were also taller in the experimental garden. It would appear that tallness here is not controlled by nutrition alone nor yet by heredity alone. The other variations noted in the field appeared to be controlled by the genetics of the individuals, inasmuch as the experimental plants retained the same degrees of variation as exhibited in the herbarium specimens obtained from the natural populations.

The assumption has been made in the past by Bonnier (1895), Clements (1929), and more recently by Weaver and Darland (1949), that observation of variation in growth based upon the same species of plant in nature was a valid means of determining the effect of the environment upon the plants observed. Such an assumption is predicated upon the hypothesis that all members of the same species will react similarly, which implies that their genetic constitutions are identical.

The contributions of Kerner (1891), Turesson (1922), and Clausen, Keck and Hiesey (1940), indicate that genetic identity throughout a species cannot be assumed, but rather that species are commonly composed of varying numbers of genetic strains, some of which may be ecologically significant. The present findings in the genus *Andropogon* tend to confirm the latter viewpoint. The delineations of ecotypes by Turesson, by Clausen, Keck and Hiesey, and by Boecher (1949), were based upon studies of species occupying a wide range of quite diverse environmental habitats, much more diverse, in fact, than those which occur in Nebraska. It is highly probable, therefore, that the variation within the species of *Andropogon* is much greater than that which occurs within this state, particularly since none of the species is restricted to Nebraska. Thus far, the authors have not been able to delimit ecotypes within the material studied, and the significance of the genetic variability is currently being investigated.

However, the present study demonstrates the impossibility of determining the effect of the environment upon a plant species without controlling either the environment or the genetic variation between the individuals studied. With both variables uncontrolled, correct conclusions can be only fortuitous.

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A NEW BACOPA FROM CALIFORNIA

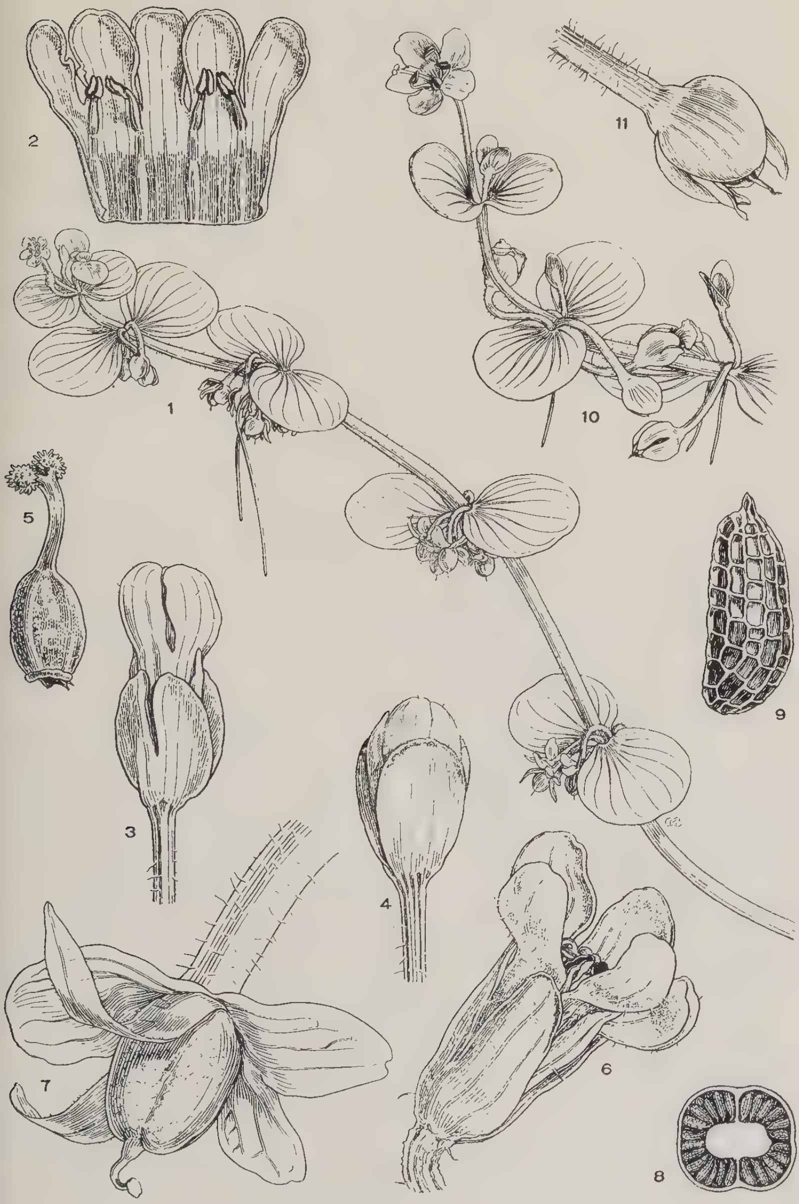
Herbert L. Mason

Bacopa Nobsiana sp. nov. *Bacopa* habitu *B. Eisenio* similis sed ab illa specie floribus parvioribus pedicellis quam folia suffulcientia brevioribus sepalis fructiferis patentibus capsulis ovoideis secundum septum valde canaliculatis discedit.

Floating, or prostrate and creeping herb, rooting at some of the nodes; stems and pedicels pilose to hirsute when young, becoming glabrate in age; leaves opposite, sessile, 1-2 or 3 cm. long, nearly as wide, orbicular-cuneate, clasping the stem, conspicuously palmately 5-7-nerved, glabrous, succulent; flowers 1-4 in each leaf axil; in anthesis pedicel and flower together, shorter than subtending leaf, sometimes elongating in fruit; calyx growing with fruit, the sepals 4 or 5, spreading in age; outer sepals 2, each 2 mm. long, almost orbicular, foliaceous, 5-7-nerved, one or sometimes both deeply cleft or parted; inner sepals oblong, 2 mm. long, 1 mm. wide, minutely ciliate-margined on lower half or sometimes glabrous, at first membranous, becoming firmer in age; corolla campanulate, white with yellow throat, lobes nearly equal, weakly disposed toward a grouping of two and three; stamens 4, inserted on throat, anthers versatile; ovary in anthesis asymmetrical; capsule broadly ovoid, 4 mm. long, conspicuously grooved up the sides and across the top along

Explanation of Figures 1-11.

Figs. 1-11. *Bacopa*. 1-9, *B. Nobsiana*: *1*, habit, × 0.8; *2*, opened corolla, × 4; *3*, *4*, two views depicting zygomorphic character of calyx, × 4; *5*, pistil, × 8; *6*, flower × 8; *7*, mature fruit showing spreading calyx lobes, × 6; *8*, cross section of ovary, × 6; *9*, seed, × 40. 10, 11, *B. Eisenii*: *10*, habit, × 0.8; *11*, mature fruit showing appressed calyx lobes, × 2. Figs. 1, 3-9 drawn from *Mason 12980*, and *Nobs & Smith 1097;* fig. 2 from *Carter 3064;* figs. 10, 11, from *Nobs & Smith 424*.



FIGS. 1-11. *Bacopa Nobsiana* and *B. Eisenii.*

the septum; seeds many, ellipsoid to oblong, testa bladdery, reticulately sculptured with 7-8 rows of transverse areolae.

Type. Rice fields, Sutter bypass, just south of Marysville, Sutter County, California, July 29, 1949, *Nobs & Smith 1097* (University of California Herbarium No. 927650).

Other collections. California: marshes along Butte Creek, Grey Lodge Game Refuge, Butte County, July 10, 1945, *Mason 12630;* eight miles north of Colusa, Colusa County, August 7, 1946, *Mason & Grant 12980;* two miles west of Colusa on Williams highway, Colusa County, August 13, 1946, *Mason & Grant 13010;* rice fields 0.1 mile east of Valley Home, Stanislaus County, June 10, 1951, *Carter 3064, 3065;* vernal border of pond, Los Banos Wildlife Refuge, 2 miles north of Los Banos, Merced County, July 6, 1948, *Nobs & Smith 10;* alkaline pools, 2 miles west of Tranquility, Fresno County, July 23, 1941, *Bacigalupi, Wiggins & Ferris 2673* (in part).

Bacopa Nobsiana occurs in shallow ponds and rice fields in the San Joaquin and Sacramento valleys of California. It closely resembles *B. Eisenii (B. rotundifolia* of western American authors, non Wettstein) in size of plant and habit. It differs in (1) the smaller size of the flower, (2) the shorter length of pedicel relative to the subtending leaf, (3) the sepals which spread in age, thus exposing the capsule, and (4) the broadly ovoid capsule which is conspicuously grooved apically along the septum.

Bacopa Eisenii is reputed to be a perennial. This may be true, but both *B. Eisenii* and *B. Nobsiana* behave as annuals in the rice fields as well as in some of the seasonal ponds in California. Apparently the herbage is relished by water fowl for it disappears suddenly with the arrival of the first migrations of ducks in late August. So complete is its disappearance that there is little opportunity to observe its possible perennial habit in the wild.

Bacopa Nobsiana is named in honor of Mr. Malcolm Nobs, who first called to my attention the differences between these two species; through his diligent field interest a fine series of specimens was obtained and many of the facts presented here were established.

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BRYOPHYTES OF CHETCO RIVER REDWOOD STATE PARK, OREGON

LEO FRANCIS KOCH

The Redwood State Park along the Chetco River, about eight miles inland from Brookings in Curry County, Oregon, is one of three known stations of the coast redwood *(Sequoia sempervirens)* north of the California border. A second isolated grove is reported several miles farther inland along the Chetco River and the third station is presumably just north of the boundary between the two states. Although many botanists have visited these areas, the moss flora there, to my knowledge, has not previously been investigated.

The Chetco River road is unsurfaced and lumber trucking raises clouds of dust which blanket the vegetation. Most discouraging is the havoc created by ruthless lumbering in the canyon. At the time of my visit, September 3 to 9, 1950, the immediate area of the redwoods on the north bank of the river appeared undisturbed although Douglas trees *(Pseudotsuga taxifolia)* in the neighborhood had been cut. Although no recently cut redwoods were seen on the ridge across the river, that area has been cleared of other marketable trees. It is a tragedy that ecologists may now never investigate this most interesting vegetational area in its original state.

During the summer and autumn before the rains begin, the winding Chetco River consists of a series of deep pools alternating with shallow stretches over gravel bars where the river can easily be forded. The pools are flanked by steep rock bluffs on their deep side and by wide gravel deposits on the other. The clean gravel beds and the gently moving river provide desirable camp sites which happily have not been commercialized.

The bryophytes which were observed in this area are listed under their respective families. I am indebted to Mrs. E. C. Sutliffe for identifying the few liverworts included. The nomenclature and arrangement of the mosses is according to Koch (1950). The collection numbers (in parentheses) are mine. A set of the specimens will be deposited in the Herbarium of the University of Michigan and duplicate specimens, where available, will be placed in the Herbarium of the University of California.

MARCHANTIACEAE

MARCHANTIA POLYMORPHA L. Juvenile.

METZGERIACEAE

METZGERIA CONJUGATA Lindb. (*3233*).

JUNGERMANNIACEAE

BLEPHAROSTOMA TRICHOPHYLLA (L.) Dum. (*3283d*).

LEPIDOZIA REPTANS (L.) Dum. (*3257*).
SCAPANIA BOLANDERI Aust. (*3222c*).

SELIGERIACEAE

BLINDIA FLEXIPES (Ren. & Card.) Kindb. (*3269*). The bent setae and the larger plants of this and other Pacific Coast specimens appear to separate them from the circumboreal species, *Blindia acuta* (H.) Br. & Sch., under which name they were formerly reported (Koch, 1950). *Blindia flexipes* belongs to the Pacific Coast Element (Koch, 1951) ranging from Alaska south to California and inland to Idaho (*Setchell*, UC; *Howell*, CAS; *Leiberg*, UC). I have not seen specimens of *B. acuta* from south of British Columbia although it probably does grow in the mountains of Washington.

DICRANACEAE

DICHODONTIUM PELLUCIDUM (H.) Sch. (*3271*).
DICRANUM FUSCESCENS Smith (*3242*).

FISSIDENTACEAE

FISSIDENS GRANDIFRONS Brid. (*3263*).
F. LIMBATUS Sull. (*3244, 3260, 3273*).
F. PAUPERCULUS Howe. (*3265, 3284a*).
F. RUFULUS B. S. G. (*3275*).

POTTIACEAE

TIMMIELLA CRASSINERVIS (Hampe) L. F. Koch (*3288*).
WEISSIA CONTROVERSA H. (*3235*).

GRIMMIACEAE

GRIMMIA ALPICOLA H. var. RIVULARIS (Brid.) Broth. (*3262, 3297*).
RHACOMITRIUM VARIUM (Mitt.) Lesq. & James (*3292*).
SCOULERIA AQUATICA Hook. (*3245, 3270*).

BRYACEAE

EPIPTERYGIUM TOZERI (Grev.) Lindb. (*3261, 3284*).
ORTHODONTIUM GRACILE B. S. G. (*3256*).

MNIACEAE

LEUCOLEPIS MENZIESII (Hook.) Steere (*3287*).
MNIUM GLABRESCENS Kindb. (*3222*).
M. INSIGNE Mitt. (*3230*).

AULACOMNIACEAE

AULACOMNIUM ANDROGYNUM (H.) Schwaegr. (*3258*).

BARTRAMIACEAE

ANACOLIA MENZIESII (Turn.) Paris (*3283a*).
BARTRAMIA POMIFORMIS H. (*3285*).

ORTHOTRICHACEAE

AMPHIDIUM CALIFORNICUM (C. Muell.) Broth. (*3283*).
ORTHOTRICHUM CONSIMILE Mitt. (*3295*).
O. LYELLII Hook. & Tayl. (*3294*).
ZYGODON VIRIDISSIMUS (Dicks.) R. Brown (*3291*).

CRYPHAEACEAE

DENDROALSIA ABIETINA (Hook.) E. G. Britt. (*3278*).

LEUCODONTACEAE

ANTITRICHIA CURTIPENDULA (H.) Brid. (*3231, 3239*).
BESTIA OCCIDENTALIS (Sull. & Lesq.) Grout (*3228a*).
PTEROGONIUM GRACILE (H.) Smith (*3228d*).

NECKERACEAE

NECKERA DOUGLASII Hook. (*3282*).
NECKERADELPHUS MENZIESII (Drumm.) Steere (*3238*).
POROTHAMNIUM BIGELOVII (Sull.) Broth. (*3225*).

THUIDIACEAE

CLAOPODIUM BOLANDERI Best (*3283b*).
C. CRISPIFOLIUM (Hook.) Ren. & Card. (*3232, 3277, 3280*).
C. WHIPPLEANUM (Sull.) Ren. & Card. (*3274*).
HETEROCLADIUM HETEROPTEROIDES Best (*3247, 3248*).

BRACHYTHECIACEAE

EURHYNCHIUM OREGANUM (Sull.) Jaeg. & Sauerb. (*3286*).
E. STOKESII (Smith) Sch. (*3293*).
PSEUDISOTHECIUM STOLONIFERUM (Brid.) Grout (*3237*).
SCLEROPODIUM COLPOPHYLLUM (Sull.) Grout (*3253, 3279*).
S. OBTUSIFOLIUM (Drumm.) Mac. & Kindb. Common.

PLAGIOTHECIACEAE

ISOPTERYGIUM ELEGANS (Brid.) Lindb. (*3234, 3250*).
PLAGIOTHECIUM DENTICULATUM (H.) Sch. (*3259*).
P. UNDULATUM (H.) Sch. (*3296*).

HYPNACEAE

HYPNUM CIRCINALE Hook. (*3241*).
H. SUBIMPONENS Lesq. (*3228*).

RHYTIDIACEAE

RHYTIDIADELPHUS LOREUS (H.) Warnst. (*3227*).
R. TRIQUETRUS (H.) Warnst. (*3226*).

POLYTRICHACEAE

ATRICHUM UNDULATUM (Hedw.) Pal.-Beauv. (*3243*).

The following information about the bryophytes in this outpost of the coast redwood forest may give some idea of the interesting ecological aspects of this area.

Marchantia polymorpha, represented by scattered, immature rosettes, was the only bryophyte observed on the occasional sandbars along the river. Stable boulders or rock masses, obviously submerged at high water, supported extensive mats of *Scleropodium obtusifolium* in which many clumps of *Scouleria aquatica, Grimmia alpicola* var. *rivularis,* and *Rhacomitrium varium* were interspersed. At the base of a steep rock bluff, one rock mass was bedecked with numerous cushions of *Blindia flexipes.*

Fissidens rufulus grew in abundance on boulders barely emergent from the water of a tributary stream, but only a single clump of *Fissidens grandifrons* was found on a submerged rock in the water from a spring. Emergent rocks alongside were covered with *Eurhynchium Stokesii.* Wet sand between rocks in seeps along the river banks supported tufts of *Dichodontium pellucidum.*

Fissidens limbatus and *Epipterygium Tozeri* were the most common inhabitants of otherwise barren, recently disturbed soil in shaded sites. *Atrichum undulatum, Scleropodium colpophyllum, Weissia controversa,* and *Timmiella crassinervis* were less abundant and apparently require more specific and permanent substrata. Comparatively stabilized banks in forested areas well above the disturbing influence of high water were usually covered with *Claopodium Whippleanum,* often intermingled with *Fissidens limbatus.* Occasionally delicate mats of *Isopterygium elegans* were seen on soil adjacent to protruding rock masses or the bases of large trees. *Hypnum subimponens* flourished on a thick deposit of silt over a rotton log with *Bestia occidentalis, Eurhynchium oreganum, Pseudisothecium stoloniferum, Pterogonium gracile, Leucolepis Menziesii,* and *Metzgeria conjugata* as associates. A large cluster of *Rhytidiadelphus loreus* and one of *Rhytidiadelphus triquetrus,* each over a foot in diameter, grew with the western sword fern *(Polystichum munitum)* along the sandy base of a shaded bank along the flood plain under California laurel *(Umbellularia californica)* and tan oak *(Lithocarpus densiflorus).* On a nearby bank was a large colony of *Mnium insigne.*

Most large rock masses, ten to twenty feet above the water line were largely covered with mats of *Pseudisothecium stoloniferum.* Where considerable soil accumulated over the tops of some of these boulders, *Leucolepis Menziesii* grew vigorously. *Pseudisothecium stoloniferum* is the predominant moss on branches of most trees in the area along the river but *Leucolepis* was found elsewhere only at the base of a large laurel with *Claopodium crispifolium* and in thick mats of other mosses like *Eurhynchium oreganum. Porothamnium Bigelovii* was common in all shaded habitats but was particularly proliferous on a huge shaded laurel trunk and formed extensive mats on the lower surfaces of large rock masses in deep shade.

Scattered clusters of *Zygodon viridissimus* and *Orthotrichum Lyellii* were collected from the trunk of large Douglas trees on which some *Hypnum circinale* was usually present. *Orthotrichum consimile* was taken from the limbs of a large rhododendron. One large rock mass in dense shade had an extensive growth of *Heterocladium heteropteroides* in crevices on its protected side.

The most luxuriant mixture of mosses in this vicinity was over large decaying logs in deep shade. *Mnium glabrescens* grew vigorously with *Eurhynchium oreganum, Plagiothecium undulatum, Pseudisothecium stoloniferum,* and *Scapania Bolanderi* on logs. The only large mat of *Plagiothecium undulatum* seen in this area was on a large well-rotted log, probably a redwood, on the wooded flood plain across the river from the redwood grove. Other logs which still retained their bark were covered with *Claopodium crispifolium* in pure stands or in mixture with *Neckera Douglasii, Bestia occidentalis, Porothamnium Bigelovii, Pterogonium gracile,* and *Pseudisothecium stoloniferum.* One large, relatively intact Douglas tree log supported a luxuriant growth of *Hypnum circinale* and scattered clumps of *Dicranum fuscescens.* On the flood plain only one small patch of *Antitrichia curtipendula* was seen on a fallen branch.

Upstream from the park, on a steep north facing bank of the river, the main limbs of large laurel trees were festooned with *Neckera Douglasii,* whereas tan oak trunks were bedecked with *Dendroalsia abietina,* and a nearby maple trunk was draped with a curtain of *Neckeradelphus Menziesii.* In shaded crevices of the adjacent rock bluff overhanging the stream, *Bartramia pomiformis* and *Amphidium californicum* occurred with *Anacolia Menziesii, Claopodium Bolanderi, Timmiella crassinervis,* and *Blepharostoma trichophylla.* A thick mat of *Antitrichia curtipendula* was found on a recently felled Douglas tree log.

The discovery of *Fissidens pauperculus* and *Orthodontium gracile* in this northernmost station of the coast redwood is of particular interest. *Fissidens pauperculus* was first found here on bare sand packed with gravel under the overhanging forest duff in deep shade in company with *Fissidens limbatus* and later with *Epipterygium Tozeri* on wet sand at the bottom of a hole left by an uprooted maple tree on the flood plain across the stream. *Fissidens pauperculus* was not abundant at either station and apparently occupies a solid but temporary substratum which is submerged at high water. On more permanent soils it presumably cannot compete with more vigorous species like *Fissidens limbatus* and *Epipterygium Tozeri,* which are found in most mesophytic sites in California. *Orthodontium gracile* was detected on the charred base of a single decayed redwood stump associated with *Aulacomnium androgynum, Plagiothecium denticulatum,* and *Lepidozia reptans.*

Fissidens pauperculus was previously known only in Marin and Santa Cruz counties in California (Koch, 1948, 1949) but has since been found in the redwoods of Napa and Monterey counties as well as in intermediate localities. *Orthodontium gracile* had been recorded from Santa Cruz, San Mateo, Sonoma, Mendocino, and Humboldt counties (Andrews, 1932; Koch, 1949) and has also been discovered recently in Monterey County. It is also known from isolated stations in Great Britain and France (Margadant & Meijer, 1950) where its peculiar range has received a great deal of attention.

The association of certain mosses with the coast redwood is believed to represent evidence for a more general concurrence in the distribution of mosses and conifers than exists between either of these groups and flowering plants (Koch, 1951) although direct evidence needs to be accumulated.

Bartramia pomiformis is the only moss reported here which is not also known to occur in California (Koch, 1950); presumably careful investigation of the northernmost counties in California will uncover that species.

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REVIEWS

Plant Embryology. By Donald Alexander Johansen. The Chronica Botanica Company, Waltham, Massachusetts. xviii + 305 pp., frontispiece, figures 1-80. 1950. $6.00, regular memoir edition; $14.00, special edition.

Because of the time-consuming nature of the work, American botanists for the most part have been unwilling to undertake monographic treatises in particular fields as was formerly done by many of the Europeans, especially the Germans. In the field of embryology the only work of such a nature has been the exhaustive survey, "Embryologie der Angiospermen" by the Austrian, Schnarf, which was published from 1927-29. Like the older workers and like many today, such as Maheshwari, Schnarf considered embryology in its broad meaning to include studies on mega- and microsporogenesis, mega- and microgametogenesis, and development of the structures of the ovule before and after fertilization, as well as study of the embryo. Since the publication of his work many additions to the literature on embryology have appeared. Therefore, Dr. Johansen's monumental work is especially welcome at this time, even though he has limited himself to what he considers embryology proper.

To Dr. Johansen plant embryology embraces embryonic morphology, embryonic physiology, and embryogeny. In the present work the treatment of embryological topics is restricted to the latter field with its divisions of embryogenesis, embryotectonics, embryogenergy, and embryonomy. He has attempted to make a correlation and evaluation of the studies on embryogeny of the Spermatophyta appearing in publications over a period of more than a century. His literature citations include those appearing prior to 1947.

The history of both angiospermic and gymnospermic embryology is discussed in the introduction.

Slightly less than one third of the book is devoted to the Gymnosperms. Dr. Johansen maintains with Hagerup and others that the Gymnosperms do not constitute a natural group and has therefore separated them into phyla or divisions: Cycadophyta, Ginkgophyta, Coniferophyta, and Ephedrophyta. One chapter is devoted to each of the fifteen families attributed to these four divisions. For each family, fertilization, the proembryo, and the embryo are described and the Taxodiaceae and Cupressaceae are further divided into subfamilies for which these topics are discussed. There is a short treatment on the comparative embryogeny of the genera of the Pinaceae in the chapter dealing with that family. The work on Gymnosperms is profusely illustrated with original line drawings or those redrawn from other authors.

The Angiosperms are termed Anthophyta and are treated as a unit. They are not segregated into the customary taxonomic groups of Dicotyledons and Monocotyledons, because there is no embryological distinction between the two.

The embryology of the Anthophyta occupies about two-thirds of the book. Before taking up embryological Types and Variations, and the special and comparative embryology of the individual orders and families, a chapter on general considerations defines the subdivisions of embryology and formulates the fundamental laws of embryonomy. The explanation for the fundamental organization of the embryo of a given species is provided for by the embryonomic laws, which may be stated: (1) the Law of Parsimony, "no more cells are produced by the embryo than are absolutely necessary"; (2) the Law of Origin, "in any particular species, the sequences of cell formation may be established in such a manner that the origin of the cells may be defined in exact terms by referring to the one or to the other of the terms of the sequence"; (3) the Law of Numbers, "the number of cells produced by different cell generations varies with the species and depends on the rapidity of the segmentation in the cells of the same generation"; (4) the Law of Disposition, "in the course of normal embryonic development, the cells are constituted by divisions in clearly determined directions and appear to occupy positions in accordance with the role which they must play"; and (5) the Law of Destination, "the cells of the proembryo of a given species, when the development is normal, give rise to clearly determined parts, and always to the same parts, of the embryonic body."

In order to elucidate the laws of embryonomy, Dr. Johansen has had recourse to formulae based on those originally used by Soueges. When formulae are combined into a table of recapitulation it is clear that they define the number of cells, disposition of cells, and role played by the cells during embryo development. The formulae indicate the precise relationships which individual cells present to one another in the course of development of the embryo.

Six main types of embryonomy are recognized according to the operation of the embryonomic laws, and a key separating them is presented. The majority of accounts which have been described in the literature can be fitted into one or another of these types. Minor deviations from each type which have occurred during evolution are termed variations. Keys separating the variations under each type are also given.

The types of embryonomic development are those first established by Schnarf. He named the type after the family to which belonged the species whose embryonomy was most completely known. Johansen has taken the root of the family name and attached the Latin suffix -ad, and with one exception has retained the names of the families used by Schnarf. Thus the first type is designated the Piperad Type because this mode of development has been most completely described in *Peperomia pellucida*, a member of the Piperaceae. Variations from the type are designated by the name of the genus whose embryonomy departs in a minor fashion from the type, as the *Balanophora* Variation. It is evident that this method of designating types has no phylogenetic significance since many Anthophyta in widely separated orders may show the same type of embryonomy. Many botanists will criticize this as misleading and contend that a classification that has no phyletic import is worthless. However, a somewhat similar practice of naming types has long been in use in embryo sac studies, and has been found a convenient method of designating a given type of development. In such studies the type is named for the genus in which it is first described.

The classification of embryo types of Soueges, based only on those species which he himself had investigated, was unknown to Dr. Johansen at the time he started work on his own system. He has, however, now made a comparison of the two systems and discussed them at some length.

Over half of the book consists in the special and comparative embryology of members of the Anthophyta for which embryonomic data are known. The classification of Orders and Families is according to Hutchinson's "The Families of Flowering Plants," Vol. I and II. Each species is assigned to one of the six types with their variations and a short discussion of each is included. There are numerous line drawings as in the chapters on Gymnosperms.

Three chapters at the close of the book deal respectively with apomictic embryogeny, adventitious embryogeny, and polyembryony. A glossary and indices follow. There is one index for orders and families and another for genera and species. Unfortunately there is no bibliography at the end of the entire book, literature citations being given only at the end of each chapter.

Although many will not agree with the classification that Dr. Johansen has set up, nevertheless it should act as a stimulus and point of departure for other classificatory schemes. The compilation of such a great amount of information on embryological literature between the covers of one volume is justification enough for the work. It will be of use not only to plant embryologists, but to other botanists such as cytologists, anatomists, morphologists, taxonomists, and those devoted to the study of evolution as well. Dr. Johansen is to be congratulated on furnishing them with such a wealth of information.

At present Dr. Johansen is undertaking to keep a record of species newly investigated with respect to their embryology. Because of poor library facilities he will include only those references obtained from reprints forwarded to him. Summaries will be presented from time to time in one of the regular botanical journals. Dr. Johansen can be reached at: 861 East Columbia Avenue, Pomona, California, U.S.A. He is also attempting to establish an International Commission for plant slide exchanges, and we take this opportunity to refer to this project. MARION S. CAVE, Department of Botany, University of California, Berkeley.

Manual of Phycology. An Introduction to the Algae and Their Biology. GILBERT M. SMITH, editor. The Chronica Botanica Company, Waltham, Massachusetts. xii+375 pp., 2 frontispieces, 48 figs. 1951. $7.50.

The appearance of the Manual of Phycology, long awaited by contributors as well as interested bystanders, is an event of signal importance to this branch of biology. Although there are now a number of books which deal with the algae as a whole, the Manual is unique in two respects. First, it is a cooperative undertaking in which outstanding phycologists have contributed chapters treating those phases of the field in which they are specialists. Second, the space allotted to comparative morphology and classification has been reduced to about half the total text.

The cooperative nature of the Manual has its inherent advantages and disadvantages. The summation of the training, knowledge, and experience of the contributors permits the attainment of a degree of general excellence unsurpassed in the work of any one individual. By the same token, however, the cohesion that can result only from an integrative viewpoint is much more likely to be achieved in the work of a single author than in a cooperative undertaking. To be sure, the editor is in a position to integrate to a limited extent the various contributions, at least as far as avoiding conspicuous contradictions of interpretation and overlapping of material, and in the Manual, Gilbert M. Smith has done a job which is especially commendable considering that "within each chapter the author was given a free hand and he was the sole judge of the proportionate amounts of space to be devoted to the various sections of the chapter." Nevertheless, an over-all approach manifested in a uniform style of treatment, which noticeably reinforces such a work as Professor Smith's Cryptogamic Botany, is conspicuously, and perhaps regrettably, absent in the Manual. Consequently, the Manual will probably prove of more use as a reference book than as a textbook, which perhaps was the intention of the publisher.

The allotment of space was decided by the editor, and it is to Professor Smith's credit that aspects of phycology other than comparative morphology and classification were consigned half the total text. This does not mean that the systematics of algae, a field which is still in its infancy, is thereby de-emphasized. To the contrary, reducing systematics to its proper perspective serves to emphasize to taxonomists the need for physiological (including biochemical) and ecological approaches to the problems of systematics, entailing cultural and experimental techniques. In most universities the course in phycology is at most but one semester in length and is thus of necessity devoted largely to comparative morphology and classification with only passing reference, if any, to such dynamic aspects as algal cytology, genetics, biochemistry, and physiology (especially sexuality *per se*, photosynthesis, and morphogenesis). Surely the time has come when the recognition of the importance of algae is so general that a course in the biology in addition to the morphology of these organisms is warranted. It is hoped that in the near future the usual course in phycology will be two semesters in length and thus permit a balanced treatment of the various aspects of the science. Phycologists, as well as those persons charged with teaching phycology who are not specifically trained in the field, when planning the scope of such a course and the distribution of the lectures and laboratory assignments would do well to be guided by the Manual.

Since each author has presented his topic in such great detail and completeness that even well-trained phycologists will find many unfamiliar but welcome facts in every chapter, the reviewer recognizes the prudence in restricting his critical comments to those phases in which he feels relatively at home.

The Manual is prefaced by a brief history of phycology, contributed by Gerald W. Prescott. In this topic, perhaps more than in any other, there is a diversity of opinion as to what should be included, depending upon the importance one assigns to the work of a given phycologist. Recognizing this diversity of opinion, one accepts as inevitable certain inclusions of seemingly unimportant information and omissions of relatively important contributions. However, one might wish for a more coherent and dynamic account. Although Prescott has covered the field in a remarkably comprehensive fashion, he shows somewhat less appreciation of the larger trends than is desirable. The omission of the development of schools of thought and of the concomitant clash of personalities has deprived this brief history of much potential interest. Cognizance of the Swedish-British and French encampments is essential to a full understanding of the history of phycology in the first half of the nineteenth century, especially the work of Turner, the Agardhs, Greville, and Harvey, on the one hand, and of Bory, Lamouroux, and Montagne, on the other. Prescott mentions many contributions in phases other than taxonomy, but systematic accounts of the history of morphology *per se*, physiology, and ecology are not given, nor are they to be found in any other chapter of the Manual. The omission in the bibliography of certain citations in the text is somewhat disturbing. These include Stackhouse (1796), Linnaeus (1737), Hedwig (1798A), Roth (1807), Roussel (1796), Braun (1835), Rabenhorst (1853), Areschoug (1875 and 1883-1884), Borzi (1879 and 1883), De Toni (1888-1905), and others.

Next, the over-all classification of algae is concisely discussed by the editor, followed by fairly exhaustive accounts of each of the major groups. The Chlorophyta are treated by M. O. P. Iyengar, the Euglenophyta by T. L. Jahn, the Chrysophyta by F. E. Fritsch, the Pyrrophyta by H. W. Graham, the Phaeophyta by G. F. Papenfuss, the Cyanophyta by Francis Drouet, and the Rhodophyta by Kathleen M. Drew. Certain of these accounts are truly scholarly. Many phycologists will undoubtedly take exception to Iyengar's classification of the siphonous green algae wherein he recognizes only the one order Siphonales. In failing to attribute ordinal importance to the fundamental process of segregative division characteristic of the Siphonocladales and to the radial symmetry and consequent vegetative elaboration peculiar to the Dasycladales, Iyengar stands in marked disagreement with leading authorities on the siphonous complex, including Børgesen and Feldmann. Recent work of Dr. Lois L. Eubank, as yet published only in abstract form (News Bull. Phyc. Soc. Am., no. 3, p. 26. 1948), supports Børgesen and Feldmann rather than Iyengar. The systematic accounts are concluded by a chapter on the fossil algae, contributed by J. Harlan Johnson.

The remaining portion of the Manual, perhaps more than the portion already discussed, brings together for the first time vast quantities of information. The next seven chapters, in fact, are of the nature of reviews. Long overdue, they fill the need adequately. Comprehensive reviews are given by H. C. Bold on algal cytology, G. M. Smith on sexuality in algae, Harold H. Strain on the pigments of algae, L. R. Blinks on the physiology and biochemistry of algae, L. H. Tiffany on the ecology of freshwater algae, Jean Feldmann on the ecology of marine algae, and Bostwick H. Ketchum on plankton algae. The chapter by Blinks is especially commendable and includes an exhaustive bibliography. The omission of Hammerling's work on morphogenesis in *Acetabularia,* though regrettable, is perhaps to be attributed to the general unavailability of his papers until very recently. Following a lucid discussion of the factors which affect the distribution of marine algae, Feldmann deals with bionomic divisions and life forms. In the latter two sections he presents complex systems of terminology (which have been proposed previously). When one reads that *Caulerpa prolifera* is an "infralittoral hemicry[p]tophycean with rhizomes, psammophilic-pelophilic, eurythermic-megathermic, euryphotic, euryhaline, galenophilic [species]," one wonders whether the means have not overwhelmed the end. If one were not already familiar with *Caulerpa* from experience in the field, would one readily draw from this frightening array of terms a picture of a broadly tolerant rhizomatous alga living in protected sandy or muddy habitats in the sublittoral zone? In the brief discussion of the marine vegetation of the different parts of the world, Feldmann has regrettably omitted the highly significant results of the investigations of the intertidal ecology of South Africa, conducted by the Department of Zoology of the University of Cape Town under the direction of Professor T. A. Stephenson.

Two useful chapters are appended to the Manual. Methods for the cultivation of algae are discussed by E. G. Pringsheim, and D. A. Johansen summarizes algal microtechnique.

Dr. Frans Verdoorn and the Chronica Botanica Company are to be congratulated on having produced the Manual of Phycology. The great need for such a volume has been recognized and satisfactorily filled. Paul C. Silva, Department of Botany, University of California, Berkeley.